

WHAT IS CLAIMED IS:

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1. A synchronization signal generator  
comprising:

a phase locked loop unit that generates a  
high-frequency clock based on a reference clock and a  
10 synchronization detection signal; and

a plurality of pixel clock generators each of  
which generates a clock signal based on the high-  
frequency clock signal and the synchronization detection  
signal,

15 wherein each of the pixel clock generators  
includes:

a pixel clock generation unit that divides a  
frequency of said high-frequency clock so as to generate  
pulses of a reference period, a long period longer than  
20 the reference period and a short period shorter than the  
reference period, and outputting, as the pixel clock,  
one of the pulses that is designated by an output  
selection signal;

a first data generation unit that outputs a  
25 first selection signal, which selectively designates one

of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a first set of data;

5 a second data generation unit that outputs a second selection signal, which selectively designates one of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a second set of data; and

10 a synthesizing unit that synthesizes the first selection signal and the second selection signal so as to generate said output selection signal and outputs said output selection signal to said pixel clock generation unit.

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2. A synchronization signal generator  
20 comprising:

a phase locked loop unit that generates a high-frequency clock; and

a pixel clock generator that generates a clock  
25 signal based on the high-frequency clock signal and the synchronization detection signal,

wherein the pixel clock generator includes:

5 a pixel clock generation unit that divides a frequency of said high-frequency clock so as to generate pulses of a reference period, a long period longer than the reference period and a short period shorter than the reference period, and outputting, as the pixel clock, one of the pulses that is designated by output selection data;

10 a first data generation unit that outputs a first selection data, which selectively designates one of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a first set of data;

15 a second data generation unit that outputs second selection data, which selectively designates one of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a second set of data; and

20 a synthesizing unit that adds the first selection signal and the second selection signal so as to generate said output selection data and output said output selection data to said pixel clock generation unit.

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3. The synchronization signal generator as claimed in claim 2, wherein values of the output selection data designating the reference period, the long period and the short period are equal to numerical values a, b and c, respectively, and said synthesizing unit sets the output selection data to the value a when a result of addition is  $a \times 2$  or  $b+c$ , and to the value a when a result of addition is  $a+b$ , and said synchronization unit sets the output selection data to the value b and carries over a remainder b to a following pixel when a result of addition is  $b \times 2$ , and said synchronization unit sets the output selection data to the value c and carries over a remainder c to a following pixel when a result of addition is  $c \times 2$ .

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4. The synchronization signal generator as claimed in claim 3, wherein the values a, b and c are set to 0, 1 and 3, respectively.

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5. The synchronization signal generator as claimed in claim 2, wherein a plurality of said pixel clock generators are provided that shares said single phase locked loop unit.

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6. A synchronization signal generator  
10 comprising:  
a phase locked loop unit that generates a high-frequency clock; and  
a pixel clock generator,  
wherein the pixel clock generator includes:  
15 a pixel clock generation unit that divides a frequency of said high-frequency clock so as to generate pulses of a reference period, a long period longer than the reference period and a short period shorter than the reference period, and outputting, as a pixel clock, one  
20 of the pulses that is designated by output selection data;  
a first data generation unit that outputs first selection data, which selectively designates one of the pulses, in synchronization with said pixel clock  
25 in accordance with a time-series distribution of the

pulses of each period defined by a first set of data;

a second data generation unit that outputs  
second selection data, which selectively designates one  
of the pulses, in synchronization with said pixel clock  
5 in accordance with a time-series distribution of the  
pulses of each period defined by a second set of data;  
and

a synthesizing unit that synthesizes the first  
selection data and the second selection data so as to  
10 generate said output selection data,

wherein values of the data designating the  
pluses of the reference period, the long period longer  
than the reference period and the short period shorter  
than the reference period are set to numerical values a,  
15 b and c, respectively, and

wherein said synthesizing unit sets the  
output selection data to the value a when both the first  
selection data and the second selection data are equal  
to a, and sets to the value b when one of the first  
20 selection data and the second selection data is equal to  
a and the other is equal to b;

said synthesizing unit sets the output  
selection data to the value b and carries over a  
remainder b to a following pixel when both the first  
25 selection data and the second selection data are equal

to b, and sets to the value a when one of the first selection data and the second selection data is equal to b and the other is equal to c; and

5       said synthesizing unit sets the output selection data to the value c and carries over a remainder c to a following pixel when both the first selection data and the second selection data are equal to c.

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7. The synchronization signal generator as claimed in claim 6, wherein the values a, b and c are  
15 set to 0, 1 and 3, respectively.

20       8. The synchronization signal generator as claimed in claim 6, wherein a plurality of said pixel clock generators are provided that shares said single phase locked loop unit.

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9. An image forming apparatus comprising:  
a charger that electrically charges a  
plurality of photoconductors;  
a synchronization signal generator according  
5 to claim 1;

an optical modulator that switches image  
signals for image forming of each color in  
synchronization with each pixel clock generated by each  
clock generator of said synchronization signal generator,  
10 and radiating light beams corresponding to the image  
signals;

an exposure optical system that projects and  
scans the light beams on the respective photoconductors;

a developing unit that develops a latent image  
15 on each of the photoconductors with each color toner to  
form visible images in each color;

a transfer unit that transfers the visible  
images on a transfer sheet in an overlapping state;

a front-end synchronization detection sensor  
20 that detects each light beam for each color image  
forming projected on a front-end of each main-scanning  
line for each color image forming so as to generate a  
front-end detection signal for each main-scanning line;

a rear-end synchronization detection sensor  
25 that detects each light beam for each color image



forming projected on a rear-end of each main-scanning line for each color image forming so as to generate a rear-end detection signal for each main-scanning line; and

5                   a main-scanning magnification correction unit that measures an interval from the front-end detection signal to the rear end detection signal for at least one color, and operating the first set of data addressed to each color in accordance with a measured value of the  
10   interval.

15                   10. The image forming apparatus as claimed in claim 9, wherein a measurement of the interval is performed by counting said high-frequency clock from a time when the front-end detection signal is generated until a time when the rear-end detection signal is  
20   generated.

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11. The image forming apparatus as claimed in claim 9, wherein the main-scanning magnification correction unit adjusts the frequency of said high-frequency clock so that the measurement value with  
5 respect to the light beam of a reference color matches a reference value, and the main-scanning magnification correction unit also adjusts a number of pixels to which the pulses of the long period or the short period contained in the first set of data and an interval of  
10 insertion.

12. The image forming apparatus as claimed in claim 9, wherein when the main-scanning magnification correction between pages is specified, in the main-scanning magnification correction, the main-scanning magnification correction unit adjusts a number of pixels  
20 to which the pulses of the long period or the short period contained in the first set of data and an interval of insertion with respect to the light beams for each color in accordance with a difference between the measured value and the reference value.

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13. An image forming apparatus for forming a color image, comprising:

a modulator that modulate each of light beams emitted from a plurality of light sources;

5 a front-end synchronization detection sensor that generates a synchronization signal providing a reference for a main-scanning line; and

a rear-end synchronization detection sensor that detects a position of a rear-end of one line,

10 wherein an image is formed on a photoconductor by irradiating the light beams onto the photoconductor through a scanner optical system, and a main-scanning magnification correction is performed according to a result of measurement of an interval between a front-end  
15 synchronization detection signal and a rear-end synchronization detection signal,

said image forming apparatus further comprising:

a phase locked loop unit that is common to the  
20 plurality of light beams and generates a high-frequency clock, which corresponds to a setting value, from a reference clock,

wherein the high-frequency clock generation means includes:

25 a pixel clock generation unit that generates

one of a reference period, a short period shorter than the reference period and a long period longer than the reference period on an individual pixel basis by dividing a frequency of the high-frequency clock; and

5           a pixel clock control unit for controlling designation information to the pixel clock generation means on an individual pixel basis,

          wherein the pixel clock control unit includes:

          a first control unit that corrects the pixel  
10   clock in accordance with a result of measurement of an interval between the front-end synchronization detection signal and the rear-end synchronization detection signal so as to correct a magnification error in one line;

          a second control unit that corrects the pixel  
15   clock in accordance with expansion and contraction distortion data previously acquired so as to correct an expansion and contraction distortion due to characteristics of the optical system; and

          a pixel clock correction data synthesizing  
20   unit that synthesizes main-scanning magnification correction data and pixel-width variation correction data,

          wherein a color offset between each color is corrected by adjusting the number of pixels that do not  
25   correspond to the reference period and the interval of

insertion of the pixels.

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14. The image forming apparatus as claimed in claim 13, wherein said high-frequency clock is used as a clock for measuring the interval between the front-end synchronization detection signal and the rear-end  
10 synchronization detection signal.

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15. The image forming apparatus as claimed in claim 13, wherein the frequency of said high-frequency clock is adjusted based on a reference color before performing the main-scanning magnification correction.

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16. The image forming apparatus as claimed in claim 13, wherein, when performing the main-scanning  
25 magnification correction between pages, the main-

scanning magnification correction for the reference color is performed by controlling the number of pixels to which the pixel clock that do not correspond to the reference period is applied and the interval of  
5 insertion of the pixels.

10                    17. A synchronization signal generator comprising:

                  high-frequency clock generating means for generating a high-frequency clock based on a reference clock and a synchronization detection signal; and

15                    a plurality of pixel clock generators each of which generates a clock signal based on the high-frequency clock signal and the synchronization detection signal,

                  wherein each of the pixel clock generators  
20 includes:

                  pixel clock generating means for dividing a frequency of said high-frequency clock so as to generate pulses of a reference period, a long period longer than the reference period and a short period shorter than the  
25 reference period, and outputting, as the pixel clock,

one of the pulses that is designated by an output selection signal;

first selection means for outputting a first selection signal, which selectively designates one of  
5 the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a first set of data;

second selection means for outputting a second selection signal, which selectively designates one of  
10 the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period defined by a second set of data; and

synthesizing means for synthesizing the first selection signal and the second selection signal so as  
15 to generate said output selection signal and output said output selection signal to said pixel clock generating means.

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18. A synchronization signal generator comprising:

high-frequency clock generating means for generating a high-frequency clock; and

25 a pixel clock generator that generates a clock

signal based on the high-frequency clock signal and the synchronization detection signal,

wherein the pixel clock generator includes:

pixel clock generating means for dividing a  
5 frequency of said high-frequency clock so as to generate  
pulses of a reference period, a long period longer than  
the reference period and a short period shorter than the  
reference period, and outputting, as the pixel clock,  
one of the pulses that is designated by output selection  
10 data;

first selection means for outputting first  
selection data, which selectively designates one of the  
pulses, in synchronization with said pixel clock in  
accordance with a time-series distribution of the pulses  
15 of each period defined by a first set of data;

second selection means for outputting second  
selection data, which selectively designates one of the  
pulses, in synchronization with said pixel clock in  
accordance with a time-series distribution of the pulses  
20 of each period defined by a second set of data; and

synthesizing means for adding the first  
selection signal and the second selection signal so as  
to generate said output selection data and output said  
output selection data to said pixel clock generating  
25 means.



19. The synchronization signal generator as claimed in claim 18, wherein values of the output selection data designating the reference period, the long period and the short period are equal to numerical values a, b and c, respectively, and said synthesizing means sets the output selection data to the value a when a result of addition is  $a \times 2$  or  $b+c$ , and to the value a when a result of addition is  $a+b$ , and said synchronization means sets the output selection data to the value b and carries over a remainder b to a following pixel when a result of addition is  $b \times 2$ , and said synchronization means sets the output selection data to the value c and carries over a remainder c to a following pixel when a result of addition is  $c \times 2$ .

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20. The synchronization signal generator as claimed in claim 19, wherein the values a, b and c are set to 0, 1 and 3, respectively.

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21. The synchronization signal generator as claimed in claim 18, wherein a plurality of said pixel clock generators are provided that shares said single high-frequency clock generating means.

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22. A synchronization signal generator  
10 comprising:  
high-frequency clock generating means for  
generating a high-frequency clock; and  
a pixel clock generator,  
wherein the pixel clock generator includes:  
15 pixel clock generating means for dividing a  
frequency of said high-frequency clock so as to generate  
pulses of a reference period, a long period longer than  
the reference period and a short period shorter than the  
reference period, and outputting, as a pixel clock, one  
20 of the pulses that is designated by output selection  
data;  
first selection means for outputting first  
selection data, which selectively designates one of the  
pulses, in synchronization with said pixel clock in  
25 accordance with a time-series distribution of the pulses

of each period defined by a first set of data;

second selection means for outputting second selection data, which selectively designates one of the pulses, in synchronization with said pixel clock in  
5 accordance with a time-series distribution of the pulses of each period defined by a second set of data; and

synthesizing means for synthesizing the first selection data and the second selection data so as to generate said output selection data,

10 wherein values of the data designating the pluses of the reference period, the long period longer than the reference period and the short period shorter than the reference period are set to numerical values a, b and c, respectively, and

15 wherein said synthesizing means sets the output selection data to the value a when both the first selection data and the second selection data are equal to a, and sets to the value b when one of the first selection data and the second selection data is equal to  
20 a and the other is equal to b;

said synthesizing means sets the output selection data to the value b and carries over a remainder b to a following pixel when both the first selection data and the second selection data are equal  
25 to b, and sets to the value a when one of the first

selection data and the second selection data is equal to  
b and the other is equal to c; and

said synthesizing means sets the output  
selection data to the value c and carries over a  
5 remainder c to a following pixel when both the first  
selection data and the second selection data are equal  
to c.

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23. The synchronization signal generator as  
claimed in claim 22, wherein the values a, b and c are  
set to 0, 1 and 3, respectively.

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24. The synchronization signal generator as  
20 claimed in claim 22, wherein a plurality of said pixel  
clock generators are provided that shares said single  
high-frequency clock generating means.

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25. An image forming apparatus comprising:  
comprising:

charging means for electrically charging a  
plurality of photoconductors;

5 a synchronization signal generator according  
to claim 17;

optical modulation means for switching image  
signals for image forming of each color in  
synchronization with each pixel clock generated by each  
10 clock generator of said synchronization signal generator,  
and radiating light beams corresponding to the image  
signals;

an exposure optical system that projects and  
scans the light beams on the respective photoconductors;

15 developing means for developing a latent image  
on each of the photoconductors with each color toner to  
form visible images of each color;

transfer means for transferring the visible  
images on a transfer sheet in an overlapping state;

20 front-end synchronization detection means for  
detecting each light beam for each color image forming  
projected on a front-end of each main-scanning line for  
each color image forming so as to generate a front-end  
detection signal for each main-scanning line;

25 rear-end synchronization detection means for

detecting each light beam for each color image forming projected on a rear-end of each main-scanning line for each color image forming so as to generate a rear-end detection signal for each main-scanning line; and

5                   main-scanning magnification correction means for measuring an interval from the front-end detection signal to the rear-end detection signal for at least one color, and operating the first set of data addressed to each color in accordance with a measured value of the  
10   interval.

15                   26. The image forming apparatus as claimed in claim 25, wherein a measurement of the interval is performed by counting said high-frequency clock from a time when the front-end detection signal is generated until a time when the rear-end detection signal is  
20   generated.

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27. The image forming apparatus as claimed in claim 25, wherein the main-scanning magnification correction means adjusts the frequency of said high-frequency clock so that the measurement value with  
5 respect to the light beam of a reference color matches a reference value, and the main-scanning magnification correction means also adjusts a number of pixels to which the pulses of the long period or the short period contained in the first set of data and an interval of  
10 insertion.

15 28. The image forming apparatus as claimed in claim 25, wherein when the main-scanning magnification correction between pages is specified, in the main-scanning magnification correction, the main-scanning magnification correction means adjusts a number of  
20 pixels to which the pulses of the long period or the short period contained in the first set of data and an interval of insertion with respect to the light beams for each color in accordance with a difference between the measured value and the reference value.

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29. An image forming apparatus for forming a color image, comprising:

modulation means for modulating each of light beams emitted from a plurality of light sources;

5 front-end synchronization detection means for generating a synchronization signal providing a reference for a main-scanning line; and

rear-end synchronization detection means for detecting a position of a rear-end of one line,

10 wherein an image is formed on a photoconductor by irradiating the light beams onto the photoconductor through a scanner optical system, and a main-scanning magnification correction is performed according to a result of measurement of an interval between a front-end  
15 synchronization detection signal and a rear-end synchronization detection signal,

said image forming apparatus further comprising:

high-frequency clock generation means common  
20 to the plurality of light beams for generating a high-frequency clock, which corresponds to a setting value, from a reference clock,

wherein the high-frequency clock generation means includes:

25 pixel clock generation means for generating



one of a reference period, a short period shorter than the reference period and a long period longer than the reference period on an individual pixel basis by dividing a frequency of the high-frequency clock; and

5 pixel clock control means for controlling designation information to the pixel clock generation means on an individual pixel basis,

wherein the pixel clock control means includes:

10 a first control unit that corrects the pixel clock in accordance with a result of measurement of an interval between the front-end synchronization detection signal and the rear-end synchronization detection signal so as to correct a magnification error in one line;

15 a second control unit that corrects the pixel clock in accordance with expansion and contraction distortion data previously acquired so as to correct an expansion and contraction distortion due to characteristics of the optical system; and

20 a pixel clock correction data synthesizing unit that synthesizes main-scanning magnification correction data and pixel-width variation correction data,

wherein a color offset between each color is  
25 corrected by adjusting the number of pixels that do not

correspond to the reference period and the interval of insertion of the pixels.

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30. The image forming apparatus as claimed in claim 29, wherein said high-frequency clock is used as a clock for measuring the interval between the front-end  
10 synchronization detection signal and the rear-end synchronization detection signal.

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31. The image forming apparatus as claimed in claim 29, wherein the frequency of said high-frequency clock is adjusted based on a reference color before performing the main-scanning magnification correction.

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32. The image forming apparatus as claimed in  
25 claim 29, wherein, when performing the main-scanning

magnification correction between pages, the main-scanning magnification correction for the reference color is performed by controlling the number of pixels to which the pixel clock that do not correspond to the  
5 reference period is applied and the interval of insertion of the pixels.

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33. A method of generating a synchronization signal, comprising:

generating a high-frequency clock based on a reference clock and a synchronization detection signal;

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dividing a frequency of said high-frequency clock so as to generate pulses of a reference period, a long period longer than the reference period and a short period shorter than the reference period, and outputting, as a pixel clock, one of the pulses that is designated

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by an output selection signal;

generating a first selection signal, which selectively designates one of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period

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defined by a first set of data;

generating a second selection signal, which selectively designates one of the pulses, in synchronization with said pixel clock in accordance with a time-series distribution of the pulses of each period  
5 defined by a second set of data;

synthesizing the first selection signal and the second selection signal so as to generate said output selection signal; and

generating the synchronization signal in  
10 accordance with said pixel clock and said synchronization detection signal.

15

34. A method of generating a synchronization signal, comprising:

generating a high-frequency clock based on a reference clock and a synchronization detection signal;

20 dividing a frequency of said high-frequency clock so as to generate pulses of a reference period, a long period longer than the reference period and a short period shorter than the reference period, and outputting, as a pixel clock, one of the pulses that is designated  
25 by output selection data;

generating first selection data, which  
selectively designates one of the pulses, in  
synchronization with said pixel clock in accordance with  
a time-series distribution of the pulses of each period  
5 defined by a first set of data;

generating second selection data, which  
selectively designates one of the pulses, in  
synchronization with said pixel clock in accordance with  
a time-series distribution of the pulses of each period  
10 defined by a second set of data;

summing the first selection signal and the  
second selection signal so as to generate and output  
said output selection data; and

generating the synchronization signal in  
15 accordance with said pixel clock and said  
synchronization detection signal.

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35. A method of generating a synchronization  
signal, comprising:

generating a high-frequency clock based on a  
reference clock and a synchronization detection signal;

25 dividing a frequency of said high-frequency

clock so as to generate pulses of a reference period, a  
long period longer than the reference period and a short  
period shorter than the reference period, and outputting,  
as a pixel clock, one of the pulses that is designated  
5 by output selection data;

generating first selection data, which  
selectively designates one of the pulses, in  
synchronization with said pixel clock in accordance with  
a time-series distribution of the pulses of each period  
10 defined by a first set of data;

generating second selection data, which  
selectively designates one of the pulses, in  
synchronization with said pixel clock in accordance with  
a time-series distribution of the pulses of each period  
15 defined by a second set of data;

synthesizing the first selection data and the  
second selection data so as to generate said output  
selection data, and

generating the synchronization signal in  
20 accordance with said pixel clock and said  
synchronization detection signal,

wherein values of the data designating the  
pluses of the reference period, the long period longer  
than the reference period and the short period shorter  
25 than the reference period are set to numerical values a,

b and c, respectively, and

wherein the step of synthesizing includes:

setting the output selection data to the value  
a when both the first selection data and the second  
5 selection data are equal to a, and sets to the value b  
when one of the first selection data and the second  
selection data is equal to a and the other is equal to  
b;

setting the output selection data to the value  
10 b and carries over a remainder b to a following pixel  
when both the first selection data and the second  
selection data are equal to b, and sets to the value a  
when one of the first selection data and the second  
selection data is equal to b and the other is equal to  
15 c; and

setting the output selection data to the value  
c and carries over a remainder c to a following pixel  
when both the first selection data and the second  
selection data are equal to c.

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36. A method of forming an image, comprising:  
25 electrically charging a plurality of

photoconductors;

generating a line synchronization signal  
according to the method of claim 34;

switching image signals for image forming of  
5 each color in synchronization with each pixel clock, and  
radiating light beams corresponding to the image  
signals;

projecting and scanning the light beams on the  
respective photoconductors;

10 developing a latent image on each of the  
photoconductors with each color toner to form a visible  
image in each color;

transferring the visible images on a transfer  
sheet in an overlapping state;

15 detecting each light beam for each color image  
forming that is projected on a front-end of each main-  
scanning line for each color image forming so as to  
generate a front-end detection signal for each main-  
scanning line;

20 detecting each light beam for each color image  
forming that is projected on a rear-end of each main-  
scanning line for each color image forming so as to  
generate a rear-end detection signal for each main-  
scanning line; and

25 measuring an interval from the front-end



detection signal to the rear-end detection signal for at least one color, and operating the first set of data addressed to each color in accordance with a measured value of the interval.

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37. A method of forming an image, comprising:  
10 modulating each of light beams emitted from a plurality of light sources;

generating a synchronization signal providing a reference for a main-scanning line; and

detecting a position of a rear-end of one line,  
15 wherein an image is formed on a photoconductor by irradiating the light beams onto the photoconductor through a scanner optical system, and a main-scanning magnification correction is performed according to a result of measurement of an interval between a front-end  
20 synchronization detection signal and a rear-end synchronization detection signal,

the method further comprising:

generating a high-frequency clock, which corresponds to a setting value, from a reference clock,  
25 generating one of a reference period, a short

period shorter than the reference period and a long period longer than the reference period on an individual pixel basis by dividing a frequency of the high-frequency clock;

5                   controlling designation information to the pixel clock generation means on an individual pixel basis;

                  correcting the pixel clock in accordance with a result of measurement of an interval between the  
10 front-end synchronization detection signal and the rear-end synchronization detection signal so as to correct a magnification error in one line;

                  correcting the pixel clock in accordance with expansion and contraction distortion data previously  
15 acquired so as to correct an expansion and contraction distortion due to characteristics of the optical system;

                  synthesizing main-scanning magnification correction data and pixel-width variation correction data; and

20                   correcting a color offset between each color by adjusting the number of pixels that do not correspond to the reference period and the interval of insertion of the pixels.